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INSTRUCTION MANUAL

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PR

REGULATED DC SUPPLY

design group

Model PR 310–2 (M)

Serial No. C-5.9116...

INSTRUCTION MANUAL

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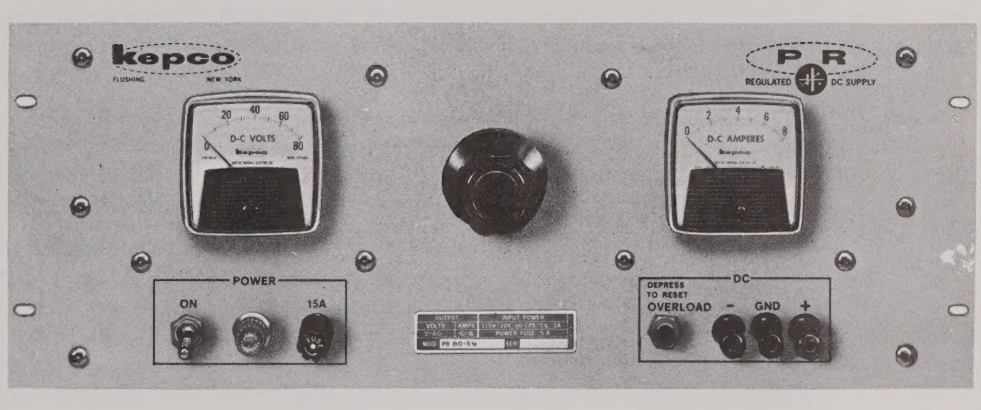

FIG. 1-1 PR POWER SUPPLY, FRONT VIEW

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SECTION I – INTRODUCTION

1-1 SCOPE OF MANUAL

1-2 This instruction manual contains information for the installation, operation and maintenance of power supplies in the KEPCO "PR" DESIGN GROUP.

1-3 GENERAL DESCRIPTION

1-4 The KEPCO "PR" DESIGN GROUP consists of a series of heavy duty, line regulated DC power supplies with standard rack dimensions (all 19 inch wide). The power supplies are adjustable from approximately zero to their maximum rated output voltage by a single control, or by a two-position range switch in combination with a control (Refer to Table 1–1). The circuitry of the PR power supply consists basically of an open loop regulator, utilizing KEPCO'S "Flux-O-Tran" constant voltage transformer. The "Flux-O-Tran" delivers a squared wave into the silicon rectifier, improving rectifier utilization and load regulation of the PR power supply. It also provides effective current limiting, which in combination with circuit breakers render the power supply completely short circuit proof. Conservatively rated components in combination with the features described, make the PR power supply an exceptionally reliable power source.

1-5 The main chassis of the PR power supply is constructed of cold rolled, cadmium plated steel. The front panel is aluminum with light gray finish. The wrap around cover is perforated steel.

1-6 SPECIFICATIONS, GENERAL

a) INPUT REQUIREMENTS:
   1) GROUP I: 115 ± 10 V AC, 60 Hz ± 5%*, single phase.
   2) GROUP II: 208 or 230 V AC (selectable) ± 10%, 60 Hz ± 5%*, three phase.
   3) GROUP I with suffix "–50": 104 ± 9 V AC, 115 ± 10 V AC, 208 ± 18 V AC, 230 ± 20 V AC (selectable), 50 Hz ± 5%*.
   4) GROUP II with suffix "–50": 208 or 230 V AC (selectable) ± 10 V AC, 50 Hz ± 5%*.

   See Table 1–1 for input current ratings.

b) OUTPUT RATINGS: See Table 1–1.

c) OPERATING TEMPERATURE (AMBIENT): –20°C to +55°C.

d) STORAGE TEMPERATURE: –40°C to +85°C.

e) COOLING: Forced air, lateral circulation. Built-in fans.

f) ISOLATION VOLTAGE: A maximum of 600 volts (DC or Peak to Peak) may be connected from either output terminal to chassis.

*NOTE: Line frequency changes will cause an approximately linear change in output voltage.

GROUP I

MODEL	DC OUTPUT RANGE		RIPPLE (MAX.) RMS	OUTPUT IMPEDANCE Ohms + μh		DIMENSIONS			MAX. INPUT AMPS at 125 V AC
	VOLTS	AMPS	%	1 kc to 10 kc	10 kc to 100 kc +μh	H	W	D	
PR 15–10M	0–7.5–15	0–10	2	0.02	0.04+0.1	3½"	19"	13⅞"	3.5
PR 15–30M	0–15	0–30	2	0.02	0.04+0.1	7"	19"	13⅞"	7.0
PR 38–5M	0–19–38	0–5	1	0.03	0.04+0.1	3½"	19"	13⅞"	4.0
PR 38–15M	0–38	0–15	1	0.03	0.04+0.2	7"	19"	13⅞"	9.0
PR 80–2.5M	0–40–80	0–2.5	0.7	0.04	0.04+0.1	3½"	19"	13⅞"	4.0
PR 80–8M	0–80	0–8	0.7	0.05	0.07+0.5	7"	19"	13⅞"	9.5
PR 155–1M	0–78–155	0–1	0.6	0.1	0.1 +0.1	3½"	19"	13⅞"	3.0
PR 155–4M	0–155	0–4	0.6	0.1	0.1 +0.5	7"	19"	13⅞"	9.0
PR 220–3M	0–220	0–3	0.5	0.2	0.1 +0.5	7"	19"	13⅞"	9.0
PR 310–0.6M	0–165–310	0–0.6	0.5	0.3	0.1 +0.1	3½"	19"	13⅞"	3.0
PR 310–2M	0–310	0–2	0.5	0.3	0.1 +0.5	7"	19"	13⅞"	9.0

GROUP II

MODEL	DC OUTPUT RANGE		RIPPLE (MAX.) RMS	OUTPUT IMPEDANCE Ohms + μh		DIMENSIONS			MAX. INPUT AMPS at 230 V AC
	VOLTS	AMPS	%	1 kc to 10 kc	10 kc to 100 kc +μh	H	W	D	
PR 20–100AM	0–20	0–100	3	0.05	0.06+0.1	8¾"	19"	20"	9.0/ø
PR 40–50AM	0–40	0–50	2	0.05	0.06+0.1	8¾"	19"	20"	8.5/ø
PR 50–40AM	0–50	0–40	1.5	0.05	0.06+0.1	8¾"	19"	20"	8.5/ø

TABLE 1-1 PR DESIGN GROUP, SPECIFICATIONS

1-7 SPECIFICATIONS, PERFORMANCE

a) REGULATION, LINE:
   1) GROUP I: Less than ±1% output voltage change for 115 ± 10 V AC line variation at any output voltage within the load ranges shown in FIG. 1–2.

b) REGULATION, LOAD: See FIG. 1–3 for typical load regulation curves on all PR models.

c) RIPPLE: Maximum ripple percentage for each model is given in Table 1–1. FIG. 1–4 below shows typical ripple values at reduced output currents.

d) STABILITY: Output voltage varies less than 1% or 0.1 volt whichever is greater over a period of eight (8) hours after warm-up.

e) TEMPERATURE COEFFICIENT: Output voltage varies less than 0.05% per °C.

f) OVERSHOOT: No output voltage overshoot from turn-on, turn-off or power failure for output settings above 25% of the maximum rated voltage. Below 25% output voltage, overshoot is a function of load current and is negligible for load currents in excess of 10% of the maximum rated value.

g) PARALLEL AND SERIES CONNECTION: PR power supplies may be paralleled by adjusting their individual voltage controls to share the load. Series operation is possible up to the rated isolation voltage.

h) OVERLOAD PROTECTION: Kepco's "Flux-O-Tran" power transformer in combination with DC overload circuit breakers allow output to be shorted without adverse effects.

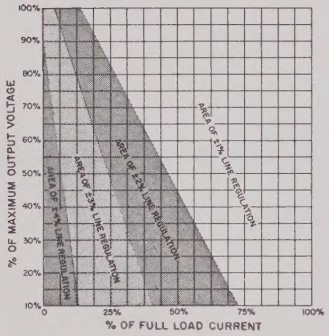


FIG. 1-2 LINE REGULATION AS A FUNCTION OF OUTPUT VOLTAGE AND LOAD CURRENT.

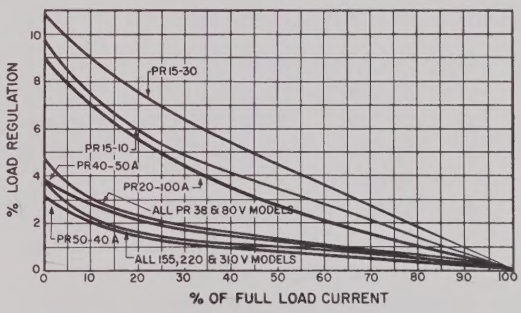


FIG. 1-3 TYPICAL LOAD REGULATION (MEASURED AT MAXIMUM RATED OUTPUT VOLTAGE AND NOMINAL LINE.)

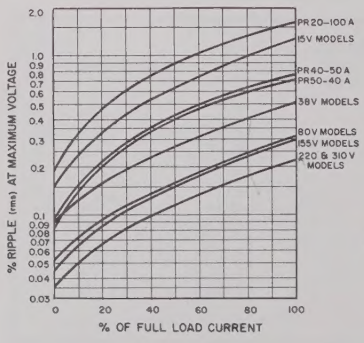


FIG. 1-4 TYPICAL RIPPLE CHARACTERISTICS AS A FUNCTION OF LOAD CURRENT

1-8 SPECIFICATIONS, PHYSICAL

a) DIMENSIONS: Refer to Table 1—1.

b) TERMINALS:

1) GROUP I: Heavy-duty "5 way" binding posts for plus (+), minus (-) and ground are provided at the front panel.

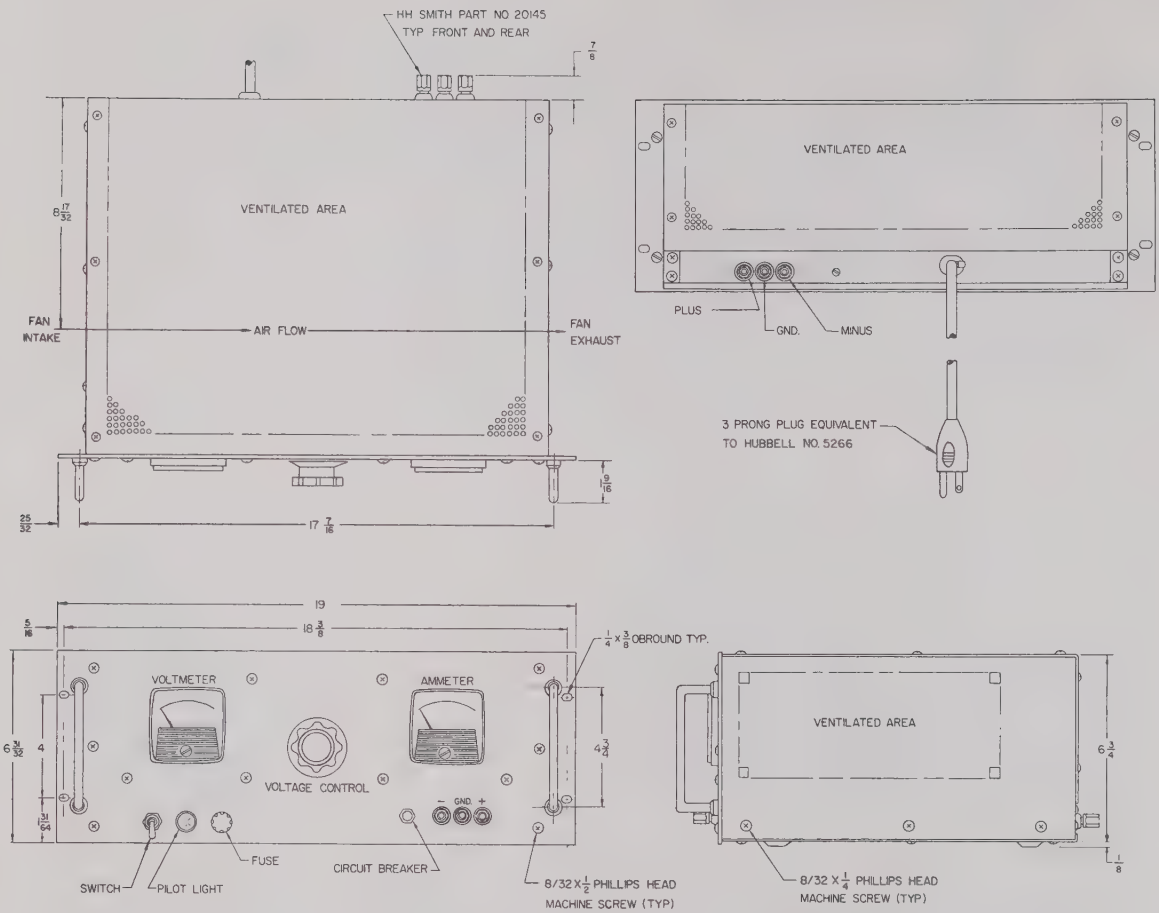
2) GROUP II: Heavy-duty output connector at the rear.

c) METERS: PR power supplies with suffic "M" have 2 1/2" square volt meter and ammeter for DC output monitoring. Accuracy of panel meters is +1% of full scale reading.

d) FINISH:

1) Case: Cadmium plated, cronac whash.

2) Front Panel: Per Federal Standard 595. Color 26440 (Light Gray).



NOTES:

1.-THIS DRAWING USED FOR MODELS: PR 15-30M, PR 38-15M, PR 80-8M, PR 155-4M, PR 310-2M, PR 220-3M.

2-MAT'L, COVERS NO 18 COLD ROLLED STEEL, CADMIUM FINISH WITH A CHRONAK WASH, PANEL ALUM. ALLOY LIGHT GRAY, FEDERAL STD 595 COLOR # 26440

3- FUSE DATA

MODEL	FUSE SIZE F10I
PR155-4M	15 AMP
PR 310-2M	15 AMP
PR 15-30M	15 AMP
PR 80-8M	15 AMP
PR 38-15M	15 AMP
PR220-3M	15 AMP

4-REFER TO KEPCO CATALOG FOR DETAILED SPECIFICATIONS.

FIG. 1-5 MECHANICAL OUTLINE DRAWING

SECTION II – OPERATION

2-1 UNPACKING AND INSPECTION

2-2 This power supply has been inspected and electrically tested at the factory prior to packing and is shipped ready for operation. After carefully unpacking, inspect the unit for shipping damage before attempting to operate. Before permanent installation,a simple performance check is recommended to ascertain the proper functioning of the power supply. If any damage is discovered, an immediate claim must be filed with the responsible transport service.

2-3 TERMINATIONS

2-4 Refer to FIG.'s 2–1 and 2–2 as well as to Table 2–1 for the location, function and description of all front panel and rear terminations.

2-5 INSTALLATION

2-6 The PR power supply is completely encased, thus making it suitable for bench use. Front panel mounting holes are provided for installation into standard 19 inch racks.

2-7 COOLING. Internal fan assemblies provide lateral air flow through the perforated side panels. AIR PASSAGES MUST BE KEPT CLEAR OF OBSTRUCTIONS. In rack installations care must be taken that the internal rack temperature does not exceed the maximum specified ambient operating temperature of the unit.

2-8 AC INPUT REQUIREMENTS

a) GROUP I and II SUPPLIES. Input requirements are clearly marked on each power supply front panel. Check carefully (see paragraph 1–6) before connecting to power line.

b) GROUP II SUPPLIES. These units may be connected to either 208 V AC or 230 V AC three-phase lines. If not specified otherwise, these units are factory connected for 208 V operation. Refer to FIG. 2–1 for conversion to 230 V operation.

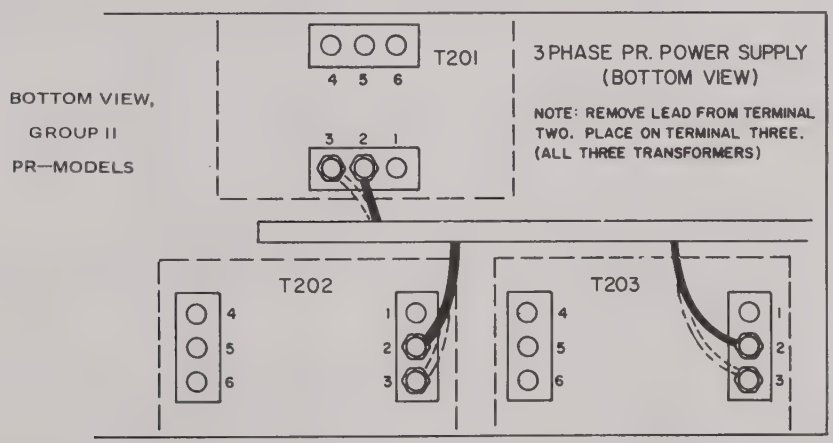


FIG. 2-1 CONVERSION FOR OPERATION ON 230 V AC (3 PHASE).

2-9 LOAD CONNECTION

2-10 Connect load to rear terminals, using the largest wire size practicable.

a) GROUP I POWER SUPPLIES: Front panel output terminals are provided, but load regulation includes any voltage drop due to load current flow from rear to front.

b) GROUP II POWER SUPPLIES: Rear terminals accept up to AWG #1 wire size.

2-11 SPECIFAL OPERATING PROCEDURES

2-12 PARALLEL OPERATION. The output of two or more PR power supplies may be connected in parallel for higher load current requirements. The voltage controls of each unit should be carefully adjusted, so that the load current is equally shared by all supplies in parallel connection.

2-13 SERIES OPERATION. The output of two or more PR power supplies may be connected in series for higher output voltage requirements. The specified isolation voltage limit must not be exceeded.

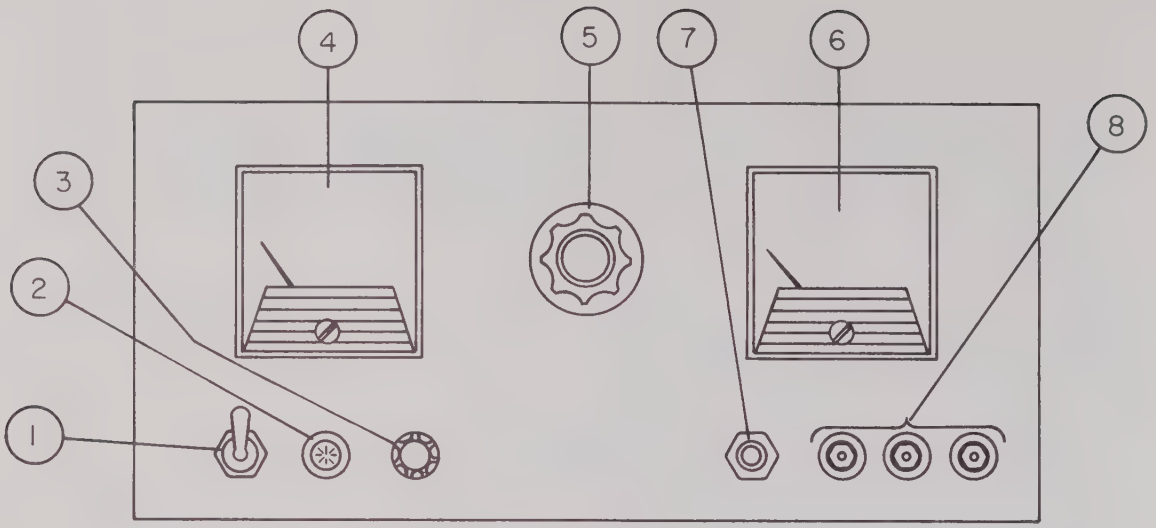


FIG. 2-2 FRONT PANEL TERMINATIONS

NO.	TERMINAL, CONTROL	FUNCTION/DESCRIPTION
1	AC POWER SWITCH	TURNS AC POWER ON/OFF
2	PILOT LIGHT	ENERGIZED WHEN AC POWER SWITCH IS "ON".
3	FUSE	PROTECTS MAIN TRANSFORMER
4	METER	MONITORS DC OUTPUT VOLTAGE
5	VOLTAGE CONTROL	ADJUSTS OUTPUT VOLTAGE FROM ZERO TO MAXIMUM RATED VALUE
6	METER	MONITORS DC LOAD CURRENT
7	CIRCUIT BREAKER	PROTECTS DC OUTPUT AND INTERNAL VARIABLE TRANSFORMER
8,9	DC OUTPUT	MINUS (-), GROUND (GND) AND PLUG (+), 5 WAY BINDING POSTS.
10	AC INPUT	3 WIRE LINE CORD WITH 3 PRONG PLUG.

TABLE 2-1, TERMINATIONS, PR GROUP I (7")

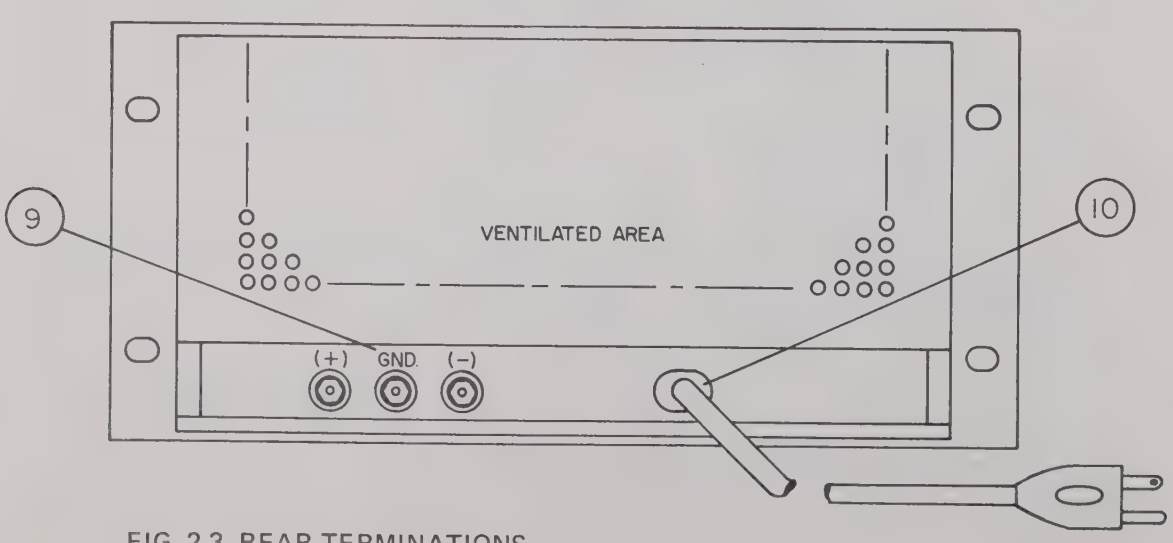


FIG. 2-3 REAR TERMINATIONS

SECTION III – THEORY OF OPERATION

3-1 GENERAL

3-2 PR Series power supplies make use of Kepco's own, patented "Flux-O-Tran" (Flux Oscillator Transformer) as a major circuit element. Significant advantages over conventional power supply circuitry are thus gained, amoung them excellent line regulation, improved load regulation characteristics; short circuit protection and better rectifier utilization.

3-3 The Flux-O-Tran consists of a primary and secondary wound separately, and coupled by a magnetic structure. As shown, a special magnetic shunt separates them. The secondary is connected to a capacitor and is made resonant at the line frequency, (60 Hz), with fairly high Q. When excited by a 60 Hz line source, the resonant circuit builds up enough flux to saturate the iron core of the transformer on each alternate half cycle. The energy is interchanged back and forth between the magnetic field and the capacitor's electrostatic field. Output from the transformer may be obtained by means of a tap on the capacitor winding as shown in FIG. 3–1, or by means of a separate output winding.

3-4 The advantages of the Kepco "Flux-O-Tran" circuit are several:

a) The peak to peak output voltage (and thus the DC from a rectifier filter) is primarily dependent upon the magnetic structure and not upon the magnitude of the line voltage. Thus the flux-oscillator provides a good degree of line regulation.

b) The output wave form from the flux-oscillator is squared, enhancing rectifier utilization. Also the peak to average voltage ratio is reduced with a squared wave form resulting in improved load regulation.

c) The transformer is immune to short circuits. When the output of the Flux-O-Tran is short circuited, the equivalent circuit modifies to that of a linear inductance in series with the output current, which limits the output to a safe maximum. (See FIG. 3–2).

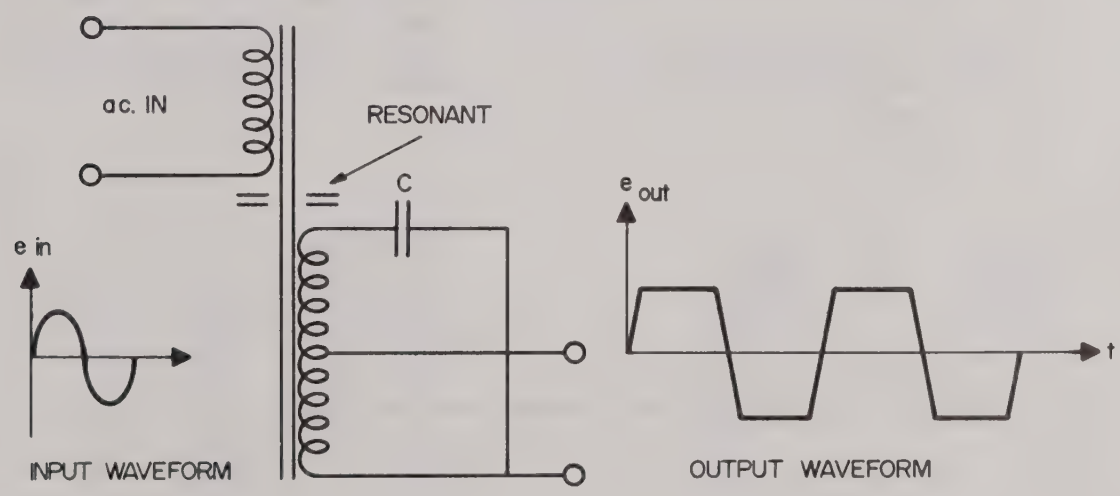


FIG. 3-1 KEPCO "FLUX-O-TRAN" REGULATOR

3-5 CIRCUIT DESCRIPTION

3-6 Input power is introduced through a three (3) wire line cord with safety plug. The third (green) wire of the line cord is connected to the chassis of the power supply and terminated on the grounding pin of the safety plug. If a properly grounded outlet is used, the power supply chassis is therefore grounded automatically.

3-7 When the AC power switch (S101)* is in the "on" position, line power is applied to the primary of the regulating transformer (T202), to the fan (B201), and to the pilot light (DS101). The fuse (F101) protects the primary circuit from excessive current in the case of overload.

3-8 Regulated AC power is transfered from the secondary of T202 to the full wave rectifier (CR201). (Models PR 15–10, PR 15–30 and PR 38–5 contain step-down transformers between the variable transformer and the rectifier). The rectified DC is filtered by the input/output capacitor (C201, in parallel with C202, C203 on some models) and finally delivered to the rear and front DC output terminals.

3-9 The bleeder resistance (R201) has the function of discharging C201 if the power supply is turned "off" without an external load connected.

3-10 The sensing element and the breaker contacts of the circuit breaker (CB101, located on the front panel) are connected in series with the contact arm of the variable transformer, thus protecting the load and the internal circuitry from excessive current. The contacts of CB101 are spring-loaded, releasing a push-button if an overload occurs. This button must be pressed-in again, once the cause for the overload has been removed.

3-11 Two panel meters provide full output read-out on all PR power supplies bearing the suffix "M". The voltmeter (M101) monitors the DC output voltage, while the ammeter (M102) is connected in series with the negative output lead, thus measuring the load current.

*NOTE: S101 is a three-position AC power/range switch on the following models:
PR 15–10, PR 38–5, PR 80–2.5, PR 155–1 and PR 310–0.6. Located on the front panel, S101 has three clearly marked positions: "LOW", "OFF" and "HIGH". The power supply is turned "on" in both the "LOW" AND "HIGH" position of S101. In addition, S101 selects different taps on the main transformer (T202) which allow efficient utilization of the Flux-O-Tran circuit. The variable transformer is alternately connected to either the low or high taps and covers either the zero to one half or the one half to maximum output voltage range.

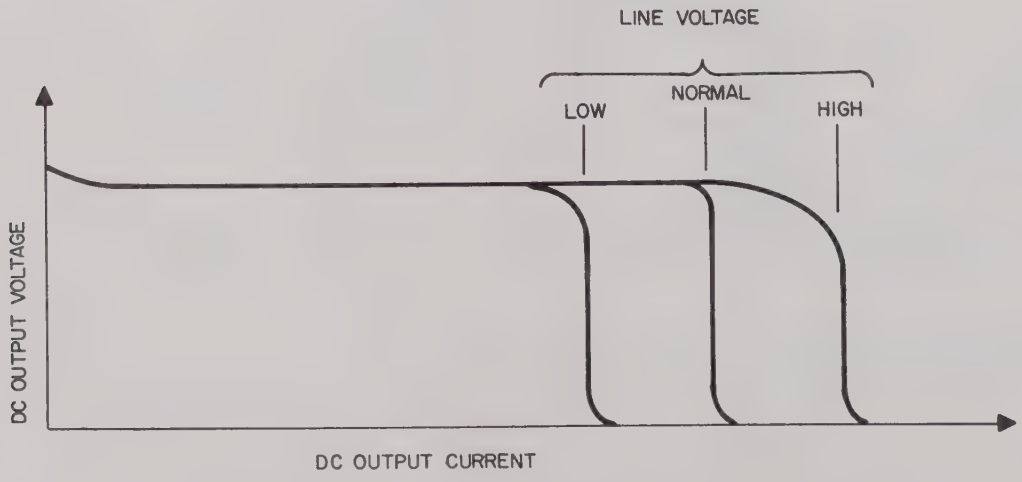


FIG. 3-2 OUTPUT OVERLOAD CURVES FOR POWER SUPPLY WITH KEPCO "FLUX-O-TRAN"

SECTION IV – MAINTENANCE

4-1 GENERAL

4-2 Conservative rating of all components and the avoidance of congested lay-out in the Kepco PR Series power supply should keep maintenance problems to a minimum. If component failure should take place however, the ease of disassembly and the readily accessible components will keep the "down time" of the equipment to a minimum.

4-3 PERFORMANCE CHECK

4-4 Measurement of the significant parameters of a power supply is a requirement for incoming inspection, periodic maintenance, or after component replacement. Since these measurements require special techniques to insure correct results, directions for their performance are given below.

4-5 REQUIRED INSTRUMENTATION:

a) AC VARIABLE POWER SUPPLY, capable of varying the input voltage over the specified range, (See Section I) with built-in AC voltmeter and rated to deliver the necessary input current: "VOLTBOX" AC Power Supply TYPE UCIM, SUPERIOR ELECTRIC COMPANY, or its equivalent.

b) DC VOLTAGE MONITOR or differential/digital voltmeter: John Fluke Manufacturing Company, Model 803 or equivalent.

c) DC AMMETER for load current measurements, Weston Model 931 or equivalent.

d) RESISTOR LOAD, variable, to draw from minimum to maximum load as specified, and rated to dissipate the full output power of the unit under test: KEPCO, INC. Model KT 6212 or equivalent.

e) AC RIPPLE MONITOR, Vacuum Tube Voltmeter, Ballantine, Model 320 A or its equivalent.

4-6 THE FOUR TERMINAL NETWORK is an essential device for accurate measurement or regulation. It can be approximated by the method shown in FIG. 4-1 below.

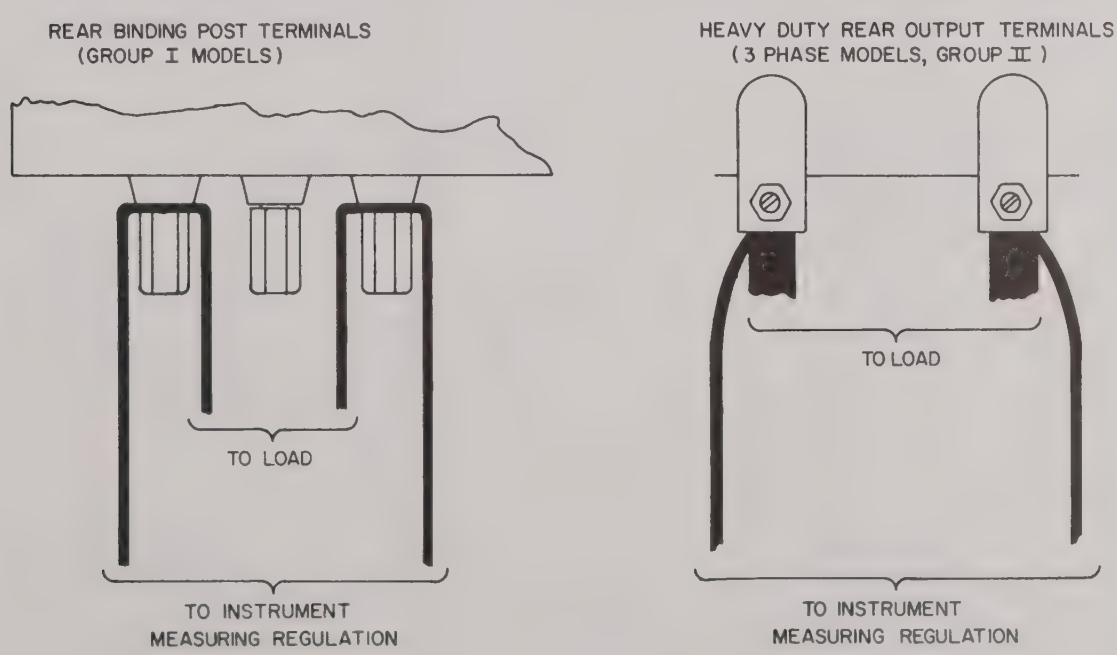


FIG. 4-1 APPROXIMATION OF A FOUR-TERMINAL NETWORK

4-7 REGULATION AND RIPPLE MEASUREMENTS, PROCEDURE

a) Connect test set-up as indicated in FIG. 4-2.

b) Set RESISTOR LOAD to draw maximum rated load current as indicated on the DC CURRENT AMMETER in series with the load.

c) Read-out DC output voltage on the DIGITAL VOLTMETER. Line regulation is equal to the change in DC output voltage (ΔE_O) as the AC input is varied over the specified range. Expressed as a percentage:

$$\% \text{ LINE REGULATION} = \frac{\Delta E_O}{E_O} \times 100\%.$$

d) Set AÇ input to its nominal value. Open, and then close S1. Load regulation is equal to the change in DC output voltage (ΔE_O) as S1 is opened and closed. Expressed as a percentage:

$$\% \text{ LOAD REGULATION} = \frac{\Delta E_O}{E_O} \times 100\%.$$

e) Ripple Measurements are taken concurrently with the described regulation measurements. Worst case conditions for ripple are "low line" and "full load". This concludes the performance measurements.

4-8 TROUBLE SHOOTING

4-9 Minor deviations from the specified performance characteristics can usually be traced to faulty measurement techniques. Re-check the test set-up as illustrated in FIG.'s 4-1, 4-2 and follow the instructions given for the performance test (Paragraphs 4-3 through 4-7).

4-10 If major deviations from the specified performance characteristics are definitely established, the unit should be serviced by first checking the voltage readings under the conditions specified on the schematic diagram (FIG. 5–2). Large deviations from the given readings may be due to part failure.

4-11 Inductors and resistors may be checked using a reliable multimeter on the appropriate ohm-scale. Capacitors can not be properly tested with an ohm-meter (except for total short). A capacitor checker, such as the Solar Manufacturing Company, Model CE is recommended.

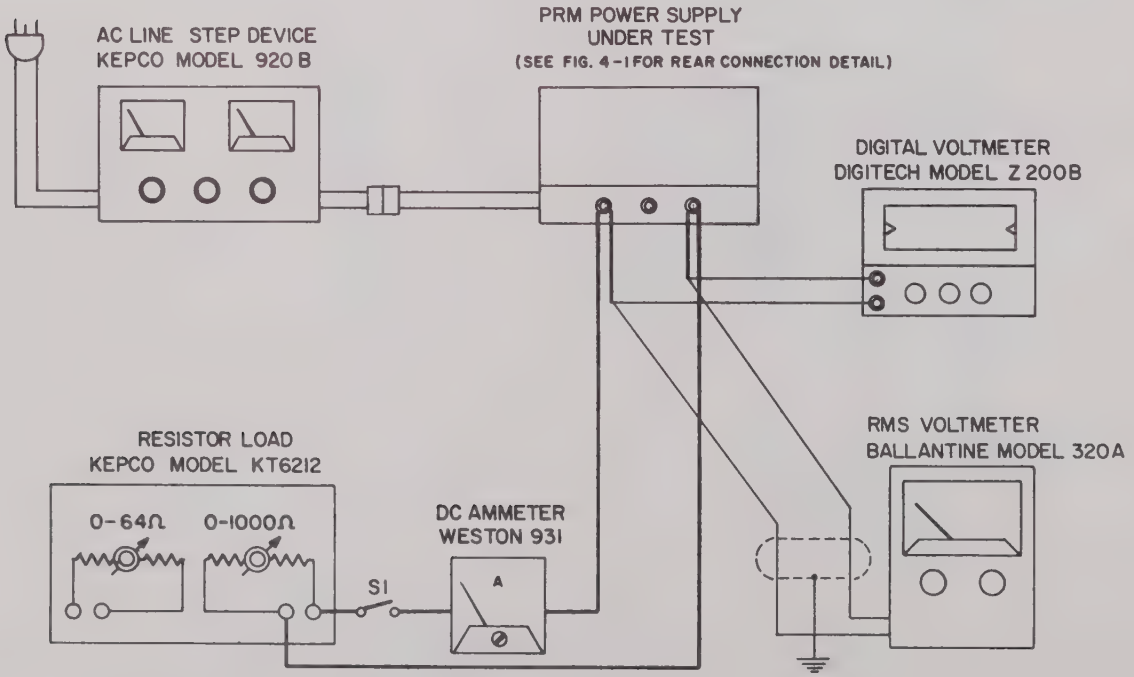


FIG. 4-2 TEST SET-UP FOR PERFORMANCE MEASUREMENTS.

SECTION V – PARTS LIST AND DIAGRAMS

5-1 GENERAL

5-2 This section contains the main schematic, the parts location diagram, and a list of all replaceable electrical parts. All components are listed in alpha-numerical order to their reference designations. Consult your Kepco Representative for replacement of parts not listed here.

tains

5-3 ORDERING INFORMATION

5-4 To order a replacement part or to inquire about parts not listed in the parts list, address order or inquiry either to your authorized Kepco Sales Representative or to:

KEPCO, INC.

131–38 Sanford Avenue

Flushing, N.Y. 11352

5-5 Specify the following information for each part:

a) Model and complete serial number of instrument.
b) Kepco part number.
c) Circuit reference designator.
d) Description.

5-6 To order a part not listed in the parts list, give a complete description and include its function and location.

kepco REPLACEMENT PARTS LIST

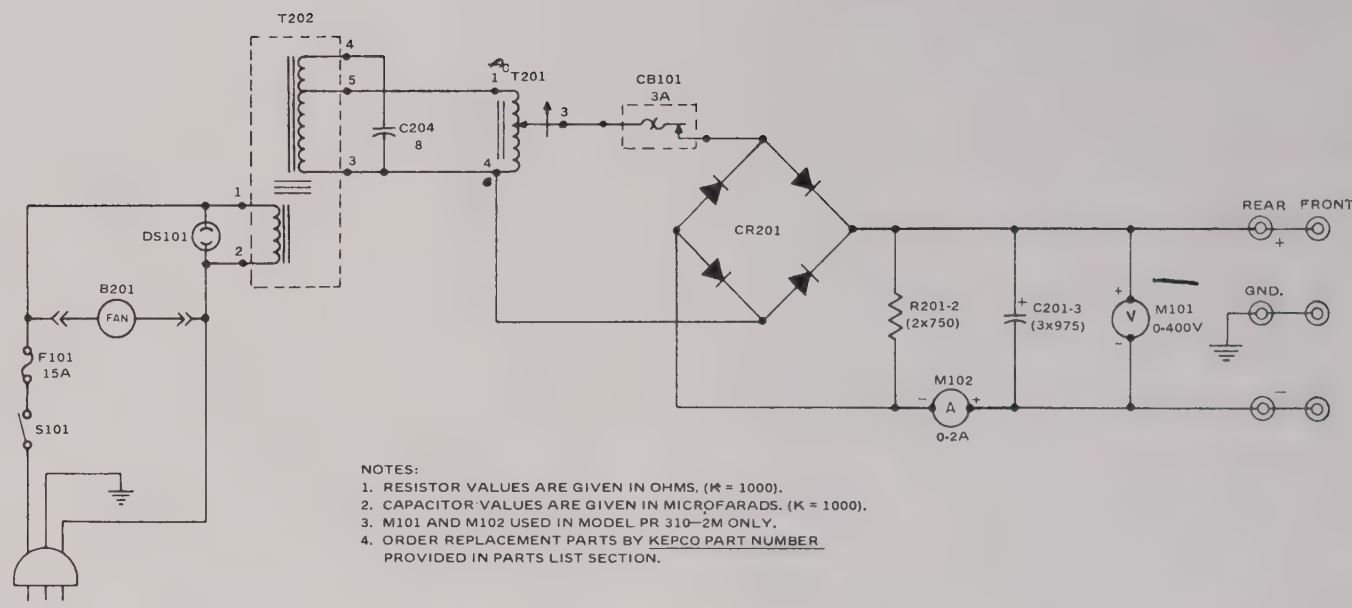
POWER SUPPLY MODEL PR 310–2 (M) Code 11-366

SCHEMATIC NO.	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (SEE NOTE)	KEPCO PART NO.
FRONT PANEL ASSEMBLY CONTAINS:				
CB101	1	Switch,Circuit Breaker 3 A, 240 V AC	ETA 45-730-P	127-0148
DS101	1	Pilot Light, Neon	General Electric NE-51	153-0024
F101	1	Fuse,Instantaneous 15 A, 250 V	Bussman ABC-15	141-0010
*M101	1	Meter 0-400 V, DC, 2 1/2"	General Electric 8DW91V206AY2	135-0157
*M102	1	Meter 0-2 A, DC, 2 1/2"	General Electric 8DW91A225BR2	135-0154
S101	1	Switch,Toggle SPST	Cutler Hammer 7501-K13	127-0012
MAIN CHASSIS ASSEMBLY CONTAINS:				
B201	1	Fan	Rotron Mfg. Muffin Fan	149-0013
C201,202,203	3	Capacitor,Electrolytic,Can 975 μF, 400 V	Sangamo DCM	117-0297
C204	1	Capacitor,Paper,Gan Type 8 μF, 600 V AC	General Electric 49F6040	117-0393
CR201	1	Rectifier Assembly Includes the following:	Kepco Inc.	124-0324
	2	Rectifier,Silicon,Stud Type	General Electric 1N3213	124-0213
	2	Rectifier,Silicon,Stud Type	General Electric 1N3213R	124-0214
R201,202	2	Resistor,Fixed,Power,Tubular 750 ohm, 50 W, 5%	Hardwick Hindle 2011	115-1054
T201	1	Transformer,Variable	Superior Q216U	175-0399
T202	1	Transformer,Flux-O-Tran	Kepco Magnetics	100-1225

*Metered Models Only.

NOTE:
REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

PLEASE NOTE: THE MANUFACTURER'S NAME AND PART NUMBER LISTED FOR EACH ITEM ON REPLACEMENT PARTS LISTS, REPRESENTS AT LEAST ONE SOURCE FOR THAT ITEM AND IS LISTED SOLELY FOR THE CONVENIENCE OF KEPCO EQUIPMENT OWNERS IN OBTAINING REPLACEMENT PARTS LOCALLY. WE RESERVE THE RIGHT TO USE EQUIVALENT ITEMS FROM ALTERNATE SOURCES. KEPCO, INC.



NOTES:
1. RESISTOR VALUES ARE GIVEN IN OHMS. (K = 1000).
2. CAPACITOR VALUES ARE GIVEN IN MICROFARADS. (K = 1000).
3. M101 AND M102 USED IN MODEL PR 310–2M ONLY.
4. ORDER REPLACEMENT PARTS BY KEPCO PART NUMBER PROVIDED IN PARTS LIST SECTION.

FIG. 5-1 MAIN SCHEMATIC, MODEL PR 310–2

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PATENT NOTICE: Applicable Patent Nos. will be supplied on request.

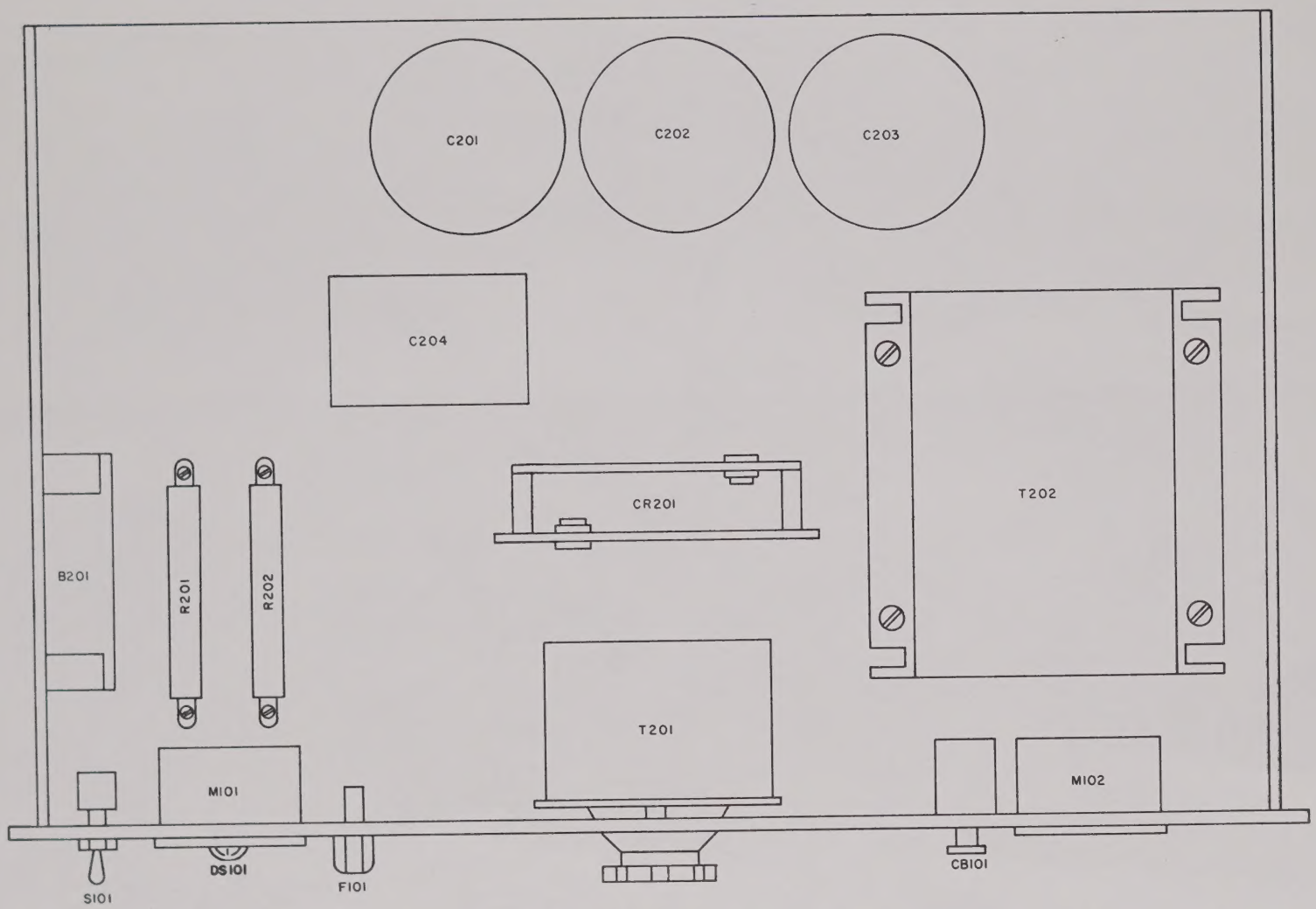
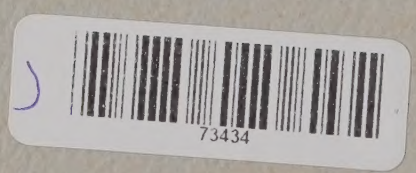


FIG. 5-2 PARTS LOCATION DIAGRAM



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